~~MULTI-POINT SEAT BELT~~SHOULDER-BELT-PORTION GUIDING ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATIONS

This is a divisional ~~continuation-in-part~~ application of the US-serial number 09/554,463 related to an international application number PCT/DE98/03270 (WO 99/24294, European Patent EP 1 037 773 B1, German Patent DE 197 49 780 C2) filed Nov. 10, 1998.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

It is an object of the present invention to provide more comfortable and convenient seat belts of a transport system (motor vehicle, ship, train or aeroplane), ~~or~~ and to enhance the survival chance in the event of any accident (front-, side-, rear-end collision and/or rollover or pile up/mass collision) or during in-flight turbulence.

~~ensure the restraint of a passenger in order to enhance the survival chance associated with lowering all acceleration-dependant forces~~

~~— in the event of any accident (front-, side-, rear-end collision and/or rollover or pile up/mass collision) of a transport system (a motor vehicle, a train or an aeroplane) or~~

~~— during turbulence-related vibrations of an aeroplane.~~

2. Discussion of the Prior Art:

It is known in the prior art to provide for ~~a~~ seat belts ~~passenger~~ of the ~~a~~ transport system D-rings, attached to the post sections (pillars, pillar portions) and non-height-adjustable shoulder belt deflectors, attached to the seat backrests.

~~— a three-point seat belt (safety belt or lap-shoulder seat belt assembly), mounted in the motor vehicle, consisting of a shoulder belt extending across the upper part of his body and of a lap belt extending across the lower part of his body; or~~

~~— a two-point seat belt, mounted in the aeroplane, acting as lap belt extending across the lower part of his body; or~~

~~— a suspender- (waist-) belt consisting of several pieces (belt-members).~~

Under constraint of great deformation of the post section, in which an extending belt portion of the seat belt, equipped with a belt retractor **13**, having a clamping device, is arranged (**Fig.** 1), the shoulder belt portion, loosely guided by a conventional height-

adjustable D-ring **12**, strangulates the neck of the belted passenger and/or injures the aorta of his neck in real-world side-crashes, causing instant death.

Passengers with a height of less than 1.5 m or more than 2 m feel uncomfortable, wearing seat belts, due to the limitation of the height-adjustment of the D-ring **12**.

Passenger, wanting to use the seat belt **1**, must make an effort to grasp the main latch plate **9**, when in resting position behind the seat backrest **3.2**.

Ref. to US No. 5,570,933 both the shoulder belt portion of the three-point seat belt, loosely guided by the shoulder belt deflector, the height of which cannot be adjusted and which is attached to a top and side edge of the seat backrest, and the lap belt portion are attached to the post section. This shoulder-belt deflector with fixed height is uncomfortable for a passenger of extreme body proportion, when using the seat belt.

~~It is well known to provide different restraint systems in vehicles, predominantly, three-point seat belts in various types for seats, exemplified by DE 37 41 831 A1 shown in **Fig.** 11. Evidently, when both shoulders of a passenger, conventionally belted, are not restrained in the event of an arbitrary collision with another vehicle in any direction, shown in **Figs.** 3, 4 and 7, the unrestrained shoulder can always move and/or rotate freely, thereby resulting in severe/fatal injuries in real-world accidents when~~

~~— the head crashes into the steering wheel and/or window pane and/or~~

~~— the airbag crushes the head, which, loaded by the forces related to pitch-acceleration $\ddot{U}_H$, yaw-acceleration $\ddot{O}$, longitudinal and/or lateral acceleration, is in "oop" (out of position).~~

~~Moreover, by the definition of „submarining" the belted passenger submarines (slips downward) under his seat belt thus negating the protective effect of the seat belt.~~

~~It is well known to provide two-point or lap seat belts for aeroplane seats as well as mid-portion of the rear seats of motor vehicles. This lap seat belt is far less effective than a three-point seat belt. Due to very large accelerations during a turbulence-related flight the protective effect is very low.~~

~~A substantially improved protection is proposed by two different configurations of a one-piece seat belt, exemplified by DE 26 02 875 A1 (**Figs.** 8 to 10). An „X-shaped" restraint is arranged by extending both shoulder belts crosswise over the upper part of body while the lower part of body is restrained by the lap belt. Each end of the one-piece seat belt is connected to a belt retractor, fastened in the seat backrest. Two grab rings, positioned to the headrest, move along the belt. A single or double „X-shaped" configuration is defined by~~

pulling a pair of grab rings and belt portions over the head, shoulders and head rest and engaging them in the corresponding hooks. Due to such intricate operation the seat belt remains unused.

According to US 3,977,696, US 5,123,673, US 5,411,319, DE-OS 23 45 847, DE-OS 28 13 888 and DE 196 29 878 A1 the restraint system comprises a three-point seat belt, a second shoulder belt and two belt retractors, responsible for retracting both belts. The „X-shaped" configuration, formed by extending both belts crosswise over the upper part of the body, has the following drawbacks in the event of an accident:

D1. Both belts are retracted to different length by two independently operating belt retractors within milliseconds.

D2. Under the load of the same belt force in a front collision the deformation of seat backrest, wherein both belt ends are fastened, is larger, thus increasing the forward motion. Furthermore, it is impossible to attach an energy absorber because all four belt ends are occupied.

A one-piece seat belt **1** (**Fig.** 1) ref. to DE-OS 28 13 888 is equipped with two belt retractors (not drawn), fastened to both belt ends in the seat backrest, and a belt deflector **17**, anchored to the seat frame **3.3** of the mid-portion of rear seat. The feature, proposed for a child, has the following drawbacks:

D3. When the release button **84** is depressed, the belt portion **1.1** gets entangled around the neck of passenger. For the operation of restraining and extending both belt portions into the „X-shaped" configuration, the passenger must lower his head first.

D4. Because all belt ends are occupied, it is impossible to attach energy absorbers and to adjust the belt to the size of an upper part of body **95** of an adult.

Generally, a child-seat is fastened by four auxiliary belts to the seat. Despite the „X-shaped" configuration of a one-piece seat belt to restrain a child, sitting in a child-seat, ref. to FR 2 342 872 A1 the problems, associated with the retraction of four auxiliary belts, submarining and energy absorption, remain unsolved in an accident.

Till now, trains, school buses and buses are not provided with restraint systems.

SUMMARY OF THE INVENTION

Accordingly, the principle object of the present invention is to provide for passengers of a transport system shoulder-belt-portion guiding assemblies for more convenience and enhanced survival chance of passengers in the event of an accident or during in-flight turbulence as well as to resolve the above-mentioned shortcomings.

~~seat belts, each, equipped with a belt retractor, solely responsible for retraction, blocking and tightening or for protraction, a lower belt deflector to loosely guide a belt portion and multi-attachment points (multi-points of restraint), restrains a passenger in multi-attachment points, in order to lower and distribute the acceleration-dependent loads, shown in **Fig.** 3 and **Tables** 1 to 3, to the multi-attachment points in the event of any accident thereof or turbulence-related vibrations of an aeroplane. Nowadays, belt tighteners are incorporated into belt retractors, for example, of MB-500-SL in order to save costs, assembling time and space.~~

~~A second object of the present invention resides in a user-friendly belt-feeding device to ease the restraint and in a master release button, when depressed, to release all latch plates from the buckle assemblies and/or return the belt-feeding device to the home position.~~

A second ~~third~~ object of the present invention resides in a cost-, space-saving integration of a height-adjustable shoulder-belt deflector, a head rest and the shoulder-belt-portion of a three- or ~~the~~ multi-point seat belt into the shoulder-belt-portion guiding assembly~~, equipped with energy absorbers, and the seat into a baby-cot, child-seat or safety seat, illustrated in **Figs.** 1, 23~~.

INDUSTRIAL APPLICABILITY

It should be apparent that the invention provides ~~a~~ substantially ~~improved restraint~~ more convenience and greater survival chance including the following features:

~~— The survival chance is enhanced by the restraint of~~

~~— both shoulders and the torso, when the passenger is thrown forward (**Fig.** 4, **Table** 3) and/or subjected to the yaw Ö-acceleration-dependent torque $T_ö$, and~~

~~— both thighs and the lower part of the body, when the passenger submarines.~~

~~— Because the belt retractor is attached to one belt end, a number of sets of energy absorbers ref. to WO 99/24292 (PCT/DE98/03271, European Patent EP 1 037 771 B1, German Patent DE 197 58 498 C2, pending US and CA patent) or German Patent DE 197 58 497 C2 can be attached to the other belt end (**Figs.** 12a, 12b, 18), thus gradually absorbing large impact energy below the respective injury-related values. The inventor of the present~~

~~application has submitted those patent documents and applications to CIPO as well as USPTO. The energy absorber consists of a number of clamping elements, having sites of predetermined fracture, and a retaining element, which, fastened to the seat backrest frame and/or seat frame, can serve as an integral part thereof.~~

~~Owing to the different positions of buckle assemblies, in plug-in connection with the respective latch plates, passengers of different body proportions can adjust the belts by themselves. Moreover, the seats, equipped therewith, for adults can be modified for children and vice versa, thus augmenting the rate of seat occupancy in a bus, train or an aeroplane, exemplified in **Fig.** 23.~~

a) ~~In another embodiment an upper belt deflector **5b** (**Fig.** 15), in plug-in connection with the buckle assembly **4**, or the buckle assembly **4** is height-adjustable. Energy absorbers, above-mentioned, can be connected to this buckle assembly. Upon the use~~Use of the height-adjustable shoulder-belt deflector **5b** (**Fig.** 3) or of the shoulder belt deflector **5** (**Fig.** 1), each upper portion of which is projected through the top edge of the seat backrest, makes the conventional height-adjustable D-ring **12**, attached to the B-, C-, D-post section ~~(pillar, pillar portion)~~, shown in **Fig.** 1, unnecessary. ~~or to the top edge of the seat backrest, is no longer needed. When the belt deflector **5b** is not height-adjustable, it can be connected to energy absorbers which absorb energy and dampen vibration when the first shoulder belt portion moves it up.~~

b) In another embodiment the ~~upper~~ shoulder-belt deflector **5a** (**Fig.** ~~13~~2) can be rigidly attached to the head rest **3.6a** as well as to one of the head-rest tubes **5.10** or the shoulder-belt deflector **5b** if replacing the aperture **5.9**.

c) Any adjustment of the height of the head rest **3.6a** to the head automatically adjusts the height of the ~~upper~~ shoulder-belt deflector to the shoulder. This feature differs from the D-ring ref. to DE 40 10 452 A1, which is in contact with the shoulder belt, when the passenger is thrown forward, and is moved up to intercept the head, when the passenger is thrown backward. If the belt deflector **5** is not height-adjustable but movable, it can be connected to vibration-dampening energy absorbers, ref. to US-serial number 09/554,464 (EP 1 037 771 B1, DE 197 58 478 C2, CA pending patent 2,347,040), which absorb energy and dampen vibration when the shoulder belt portion moves it up.

d) The tragedy, linked to neck-strangulation, above-mentioned, is, to a great extent, averted by the shoulder-belt deflector in conjunction with a feature of arranging the extending belt

portion and the belt retractor in the seat backrest and arranging the belt end of the lap belt to the seat frame.

~~In resting position the shoulder latch plate **2**, in plug-in connection with an assisting buckle assembly **16, 16a, 16b** fastened to the seat cushion **3.1**, B-, C-post section or seat backrest (**Figs.** 1, 2), is easily accessed by the passenger having the intention to use the belt.~~

~~The seat belt can be equipped with a belt-feeding device, manually operated or by a drive apparatus, for example, hydraulic-piston cylinder unit, electrical motor (not drawn), which enhances the convenience and comfort of the user. This drive apparatus is switched on by a pressure sensor, built to the seat, or an existing switch such as lighting-, door- or touching switch. If the belt is not engaged within a dwell time, a control device is activated to switch off the drive apparatus and to reposition the belt-feeding device in resting position.~~

e) For the convenience of the passenger, when stepping out, the shoulder-belt deflector intercepts and loosely retains the released main latch plate **9**, which is loosely held by a main-latch-plate adaptor (not drawn) fastened to the lap belt portion. He or another passenger, when taking the seat and wanting to use the seat belt, easily accesses the released main latch plate on the shoulder-belt deflector. See an alternative feature for easy access thereof, undermentioned.

~~or a quick-rescue of the passenger, when being rescued in accidents, the master-release button **84** of the buckle assembly **9.1** is depressed to release all latch plates from the buckle assemblies and/or to return the belt-feeding device to the resting (home) position.~~

~~The round rollover tubes **20.2b** of the seat backrest frame **3.4d** are designed to guide the belt housing **20.4c, 20.4d** (**Figs.** 18, 19), to act as safety bars in a rollover and to allow free view to the rear owing to openings **97R, 97L** (**Fig.** 23).~~

~~In another embodiment the seat belt can be connected to the seat in more than three attachment-points (**Figs.** 1, 14, 23), in which both thighs (femurs) are restrained, thus protecting the passenger from submarining in a front, rear collision or rollover or when in sleeping position. Unlike the suspender- (waist-) belt, consisting of several belts, the portions of multi-point seat belt need not be adjusted in length, when the circumference of the passenger varies depending on the clothes worn.~~

BRIEF DESCRIPTION OF THE DRAWINGS

A number of embodiments, other advantages and features of the present invention will be described in the accompanying ~~tables and~~ drawings with reference to the xyz global coordinate system:

~~**Table** 1 shows test data such as left / right thigh force, belt force and pitch angle of driver and co-driver in 50% offset crash test of several European vehicles.~~

~~**Table** 2 shows yaw angle O of driver / co-driver in a 50% offset crash tests.~~

~~**Table** 3 shows test data of the safest child restraint system Chico Shuttle® at the converted velocity of 55 km/h in comparison with the safest vehicle among them listed in **Table** 1.~~

Fig. 1 is a perspective view of a seat with buckle assemblies attached to the seat backrest and seat cushion as well as of ~~the~~ a 1st embodiment of a height-adjustable shoulder-belt deflector **5** and a three- or ~~restraint system consisting of a~~ multi-point seat belt **1**,~~-~~ having a main latch plate ~~**11**~~**9**, which, when the seat belt is used, is inserted and plug-in connected to a main buckle assembly **9.1** ~~along the lap belt, shoulder latch plate **2** of belt end, in the direction of arrow „Z" in plug-in connection with an upper buckle assembly **4**, and a seat belt in X-shape, formed by crossing both shoulder belt portions **1.1, 1.2**.~~

~~**Fig.** 2 is a perspective view of a seat and of the 2nd embodiment of a restraint system comprising three-point seat belt **1c** having a transition latch plate **2**, which will be inserted into a transition buckle assembly **4c** of a shoulder belt **1.11**, pulled in the direction of arrow „Z".~~

~~**Fig.** 3 illustrates load cases I, II and III in z-y plane in the event of a real-world accident.~~

~~**Fig.** 4 is a perspective view of a restrained dummy thrown forward in VW Polo® in a 50% offset crash test.~~

~~**Fig.** 5 illustrates a yaw-acceleration Ö and yaw-angle O of a vehicle about the vertical axis „z_A" in a 50% offset crash test of two identical vehicles.~~

~~**Fig.** 6 illustrates a yaw angle O of vehicle about the vertical axis „z_A" in a 50% offset crash test into a stiff barrier.~~

~~**Fig.** 7 illustrates four collision types „U1" to „U4" ref. to the research work of Institute of Vehicle Safety, a Dept. of German Insurers Association.~~

~~**Fig.** 8 is a front view of a seat belt ref. to DE-OS 26 02 875 in home position.~~

~~**Fig.** 9 is a front view of a double X-shaped seat belt ref. to DE-OS 26 02 875.~~

~~**Fig.** 10 is a front view of a single X-shaped seat belt ref. to DE-OS 26 02 875.~~

~~**Fig.** 11 is a top view of a ∠- shaped seat belt ref. to DE 37 41 831 A1.~~

~~**Fig.** 12a is a schematic, perspective view of the 1st embodiment of a buckle assembly **4a**, equipped with release cable **4.2**.~~

~~**Fig.** 12b is a schematic, perspective view of the 2nd embodiment of a buckle assembly **4b**, equipped with an electrical release motor **4.2b**.~~

Fig. ~~13~~2 is a perspective view of a 2nd embodiment of a shoulder~~an upper~~ belt deflector **5a** on~~f~~ a ~~the~~ head rest having a pair of head-rest tubes **5.10**.

~~**Fig.** 14 is a perspective view of a latch plate **11** of a lap belt portion **1.3** in plug-in connection with a buckle assembly **8** and of the 1st embodiment of a belt-feeding device **20** of the seat belt.~~

Fig. ~~15~~3 is a perspective view of a 3rd~~2nd~~ embodiment of ~~a spatially-adjusting belt-feeding device **20a** from the resting position to the operating position and of~~ a height-adjustable belt deflector **5b** having a locking handle **5.2**.

~~**Fig.** 16 is a schematic view of the 2nd and 3rd embodiment of spatially-adjusting belt-feeding devices **20a** and **20b** in kinematics from the operating position to the resting position in x-y plane.~~

~~**Figs.** 17a to 17f are schematic, perspective views of the belt-feeding device **20** in kinematics from the resting position to the operating position.~~

~~**Fig.** 18 is a schematic, perspective view of a seat, equipped with the rollover tubes **20.2b**, and of the 4th embodiment of a belt-feeding device **20c**.~~

~~**Fig.** 19 is a schematic, perspective view of a seat having the rollover tubes **20.2b**, the 5th embodiment of a belt-feeding device **20d**, provided with a safety bracket **20.6**, a height- and width-adjusting mechanism **27, 27a**.~~

~~**Fig.** 20 is a cross-sectional view of the 1st embodiment of the height- and width-adjusting mechanism **27** along the line I-I of **Fig.** 19.~~

~~**Fig.** 21 is a cross-sectional view of the height- and width-adjusting mechanism **27** along the line II-II of **Fig.** 20.~~

~~**Fig.** 22 cross-sectional view of the 2nd embodiment of the height- and width-adjusting mechanism **27a** along the line I-I of **Fig.** 19.~~

~~**Fig.** 23 is a front view of the seat **3a to 3d**, in which the restraint systems **1a to 1d** are integrated, for passengers of different weights and body proportions (sizes).~~

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The advantages of the preferred embodiments in the Chap. "INDUSTRIAL APPLICABILITY" are outlined hereinafter with regard to the functions and features thereof.

~~The method of the present invention capitalizes on the premise that a seat belt is employed to restrain a passenger in at least four attachment points of the seat to distribute all acceleration dependant loads, particularly the yaw Ö-acceleration-dependent torque $T_ö$, thereto in an accident, thus ensuring the operation of a single belt retractor to pre-tension (bias) as well as tension the belt, restraining both shoulders, upper- and lower part of the body and lowering all the loads, in particular, in co-operation with the energy-absorption when a number of sets of energy-absorbers is put into use. This will be apparent when all forces, imposed on the belted passenger, shown in **Figs.** 3 and 4, are formulated in the event of a front collision, where the loads of the mass D_S of the torso are lowered because~~

~~— the forward motion „w_v" is minimized, thus substantially reducing the pitch-acceleration $Ü_H$ and force F_{Hy} of the mass D_H of the head, and~~

~~— the yaw-acceleration Ö is minimized, thus substantially reducing the torque $T_ö$, imposed on the head. Great torque $T_ö$ is the most latent force, responsible for sudden death.~~

~~To a great extent massive head injuries can be avoided.~~

~~Load case I in z-y plane: The rotating mass D_S rotates about the rotating axis „S" at the pitch-angle U_S and mass D_H about the rotating axis „z" at the pitch-angle U_H in **Table** 1, thereby resulting in the pitch-accelerations $Ü_S$, $Ü_H$ and rotating forces F_{Sy}, F_{Hy}. The addition of both rotating forces yields the force F_V linked to the forward motion w_V of passenger, shown in **Fig.** 4.~~

~~In front- and/or rear collision the passenger is exposed to the submarining force S_y, shown in **Fig.** 14.~~

~~Load case II in x-y plane: The upper part of body is subjected to the torque $T_ö$, exerted by the yaw-acceleration Ö about the rotating axis „z". When the upper part is restrained in an X-shape, the torque is substituted by a pair of forces.~~

~~Load case III in x-z plane: The rotating mass D_S rotates about the rotating axis „S" at the rotating angle U_y and mass D_H about the rotating axis „z" at the rotating angle U_{Hy}, thereby~~

resulting in the rotating accelerations $\ddot{U}_y$, $\ddot{U}_{Hy}$ and rotating forces D_{Sy}, D_{Hy} (not drawn). In a rollover the passenger is subjected to the load F_{Sz}.

Load case IV: In turbulence-related vibrations of an aeroplane the load D_{Sy} together with D_{Hy} takes the form of periodical load $\pm F_{Hx}$, F_{Sz} of $\pm F_{Sz}$, $T_ö$ of $\pm T_ö$, S_y of $\pm S_y$ and F_{Sy} together with F_{Hy} of $\pm F_V$.

The restraint system, illustrated in **Fig.** 1, is provided with a conventional belt retractor **13** having a clamping device, housed in the B-, C-, D-post section or in one of both sides SL and SR of a seat backrest **3.2** and connected to the belt end EL. The other belt end ER is provided with a shoulder latch plate **2**, which is retained, loosely guided by a lower belt deflector **17**, fastened to the vehicle floor, and inserted into one of the buckle assemblies **4, 4a to 4c, 14, 14a, 18, 18a, 18b**, arranged in or to the seat backrest **3.2**. In all embodiments an additional latch plate **9** can move along the seat belt **1** between both belt ends EL and ER. When plug-in connecting the shoulder latch plate **2** (in the direction of arrow "Z") to the buckle assembly **4** and the latch plate **9** to the buckle assembly **9.1**, an X-shaped restraint of the upper part of body and both shoulders as well as a restraint of the lower part of body are accomplished by both belt portions **1.1, 1.2** and the lap belt portion **1.3**.

In the 2nd embodiment, shown in **Fig.** 2, a transition product, comprising conventional three-point seat belt **1c** and new parts, has to be invented due to the delay resulting from the production of multi-point seat belts **1**. The floor fitting (not shown) is replaced by lower belt deflector **17**. The end of the lower shoulder belt portion **1.11** is provided with transition latch plate **2**. The end of an upper shoulder belt **1.12** and the other end are equipped with a transition buckle assembly **4c**, having release button **84c**, and with a second belt retractor **13a**, arranged in the seat backrest **3.2**. The restraint in an X-shape is defined by plug-in connection of transition latch plate **2** with the transition buckle assembly **4c**. In order to resolve the above-mentioned drawback **D1**, the spring force of the second belt retractor **13a**, to retract the shoulder belt **1.12** on depressing the release button **84c**, is far less than of the belt retractor **13**. Despite the circumference of the restrained passenger, varying depending on the clothes worn, and the different seat position the shoulder belt portion **1.11** always projects through the lower belt deflector **17** at a sufficient length of "l_1" in order to maintain the function of the belt retractor **13** to retract, to block the belt as well as to release the retracted belt during the travel and the function of the belt tightener (not drawn), incorporated in the belt retractor, to

forcefully retract (withdraw) and tighten the belt in an accident. The release button **84c** of transition buckle assembly **4c**, arranged to or in the seat, can be controlled neither by release cable **4.2** nor by electrical release motor **4.2b**. Hence, the release button **84c** can only be activated by signals when depressing the master release button **84**.

The other end of shoulder belt **1.12** can be connected either to a coupling fitting **1.2a, 1.2b** (**Figs.** 12a, 12b, 18, 19) or to the belt retractor **13a** (belt retractor **13** shown in **Fig.** 18) having a coupling fitting **1.2b** in order to receive a number of energy absorbers to dissipate great impact energy and dampen strong vibration.

In another embodiment the shoulder belt **1.12a** consists of the transition buckle assembly **4c** and a shoulder latch plate **2a** (not shown), similar to latch plate **2**, which is plug-in connected to

- the upper buckle assembly **4, 4a to 4c, 14, 14a, 18, 18a, 18b, 18.1 to 18.3**, arranged in the seat backrest, in operation position or
- the assisting buckle assembly **16, 16a, 16b** in resting position.

When motor vehicles are already licensed, modification of different seats and three-point seat belts can easily be accomplished by arrangement of at least one buckle assembly, of the lower belt deflector **17**, of the second belt retractor **13a** and by collection of one-piece, detachable shoulder belts **1.12a** with different length. Furthermore, the latch plate **2a** can be detached from the buckle assembly by depressing the master release button **84**.

A first shoulder belt portion **1.1** is defined by the upper shoulder belt **1.12, 1.12a** and the lower shoulder belt portion **1.11**.

At an expensive modification or at new transport system the use of belt feeding device **20, 20a to 20d** enhances the convenience and comfort, where the shoulder belt **1.12, 1.12a** having transition buckle assembly **4c** is a part thereof.

Evidently, the three-point seat belt **1c** in plug-in connection with the shoulder belt **1.12, 1.12a** serves as a transition solution for the multi-point seat belt **1, 1a to 1d** during the production.

In the above-mentioned embodiments to resolve the above-mentioned drawback **D3** the upper part of body is restrained by extending the shoulder belt portions crosswise in an X-shape

c1) when at least one latch plate **2** is plug-in connected to the buckle assembly of the seat backrest; *or*

c2) when a latch plate **2**, arranged to the end ER of the first shoulder belt portion **1.1** of a belt-feeding device **20a**, **20b**, is plug-in connected to the buckle assembly of the seat backrest; *or*

c3) when the belt-feeding device **20**, **20c**, **20d** positions the first shoulder belt portion **1.1**, the belt end ER of which is arranged to or in the side SR of the seat backrest, from the operation position to a resting position.

These features c2) and c3) have the advantage that the common practise to operate the conventional three-point seat belt is preserved.

In order to resolve the above-mentioned drawbacks **D2** and **D4** great energy is absorbed and strong vibration is dampened by a large number of energy absorbers connected to the respective buckle assemblies **4**, **4a to 4c**, **4e**, **7**, **8**, **8a to 8d**, **9.1**, **14**, **14a**, **15**, **15a**, **18**, **18a**, **18b**, **18.1 to 18.3**, **19**, **19a**, **19b**, **19.1 to 19.3** (**Figs.** 1, 14, 19, 23) into which latch plates are inserted.

As shown in **Figs.** 1 and 14, the seat belt **1** is equipped with an anti-submarining latch plate **11**, which can be connected to one of the buckle assemblies **7**, **8**, **8a to 8d**, arranged in or to the seat frame **3.3**. When plug-in connected, the lap belt portion **1.3** is subdivided into two belt portions **1.3R**, **1.3L**. Owing to the restraint of both thighs the submarining problem in front- or rear collision, in rollover or turbulence-related vibration of an aeroplane is resolved. Moreover, the passenger, lying in a sleeping position, is well protected.

Because the reel (spool) of the conventional belt retractor can accommodate only a limited length of belt, it is possible that the length of the seat belt for the sleeping position is insufficient. As exemplified in **Fig.** 1, a buckle assembly **8b**, **8c** is provided with a release button **84c** and a length-adjustable belt, fastened to the seat frame, for the purpose of compensating the length of seat belt **1** between the sleeping and normal position.

A buckle assembly **8d**, provided with a release button **84d**, is attached to the front portion of the seat cushion.

Owing to the plug-in connection of the anti-submarining latch plate **11**, **25** with one of the buckle assemblies a lady in a long gown as well as a child are well protected from submarining (**Fig.** 23).

The lower belt deflector **17** comprises a housing having an attachment hole to receive a pin **17.1**. Both members can be made in one piece. If necessary, the pin **17.1** is surrounded by a sleeve **17.2** of plastics, having corrugation or knobs, which is a common part of the

conventional D-ring **12**. This D-ring **12** can be replaced by the lower belt deflector **17**. The aperture of the belt deflector **17** to loosely guide the belt portion is dimensioned to such a size to retain the latch plate **2** in resting position, thus allowing the use as a three-point seat belt.

In the 1st embodiment ref. to **Figs.** 14, 17a, 17d the belt-feeding device **20** in resting position is provided with a device to countersink the belt-feeding plate **20.9** in the seat backrest to improve the overall impression of the seat-design, whereon the sales success depends.

When the passenger takes his seat, a drive apparatus, being activated,

- moves up over the head rest the belt-feeding plate **20.9** (**Fig.** 17a) and then the guide tube **20.1** with the operating arm **20.2**, whose belt ring **20.8** houses and loosely guides the first belt portion **1.1** (**Fig.** 17b);
- rotates the operating arm and the first shoulder belt portion over the head rest, his head and in front of the upper part of his body **95** at „β" (**Fig.** 14), where in a contact position a key of the operating arm projects through a receptacle of the belt-feeding plate **20.9** or a clamping receptacle **20.11** of the belt-feeding plate **20.9a** (**Figs.** 17c, e, f); and
- countersinks the belt-feeding plate **20.9** or **20.9a** and the guide tube **20.1** with the operating arm **20.2** until reaching the operating position in which the first shoulder belt portion extends across over the upper part of his body and the drive apparatus is switched off (**Fig.** 17d).

To prevent the entanglement of the first belt portion **1.1** behind the seat, particularly when positioned furthest forward, that belt portion **1.1** in resting position is intercepted by the belt-catching member **20.7, 20.7a** (**Figs.** 14, 17a, 17b).

When the seat **3c** (**Fig.** 23) has a high seat backrest, the curved guide tube **20.1** of belt-feeding devices **20a** (**Fig.** 15) can be modified in a straight-running operating arm **20.2** of the belt-feeding device **20**.

In the 2nd or 3rd embodiment the belt-feeding device **20a** or **20b** is provided with a height-adjustable belt housing **20.4a** and radial-adjustable tube **20.3** (**Figs.** 15, 16). Both devices differ from each other by the position of the guide tubes **20.1** on the seat backrest. Each guide tube can be driven by a drive apparatus, housed in the seat backrest. The guide tube **20.1** of the belt-feeding device **20a** is pivotally attached in a stiff supporting tube **3.61** of the height-adjustable head rest **3.6a**.

~~The height of „Δh" of belt housing **20.4a**, having a latch plate **2**, plug-in connected to any buckle assembly **4, 14, 18**, is adjustable when the passenger moves two openings, facing each other, along the operating arm **20.2a**. Alternatively,~~ A three-point seat belt consists of a shoulder, lap and extending belt portion. A multi-point seat belt **1** consists of a first and second shoulder belt portion **1.1, 1.2**, a lap belt portion **1.3** and an extending belt portion **1.4** (**Fig.** 1).

In the 1st to 3rd embodiment the passenger can ~~move~~ unlock a locking member of a locking handle **5.2**~~, such as locking handle **27.5** of the height- and width-adjusting mechanism **27, 27a** (**Figs.** 15, 19 to 22)~~, to adjust the height of „Δh" of the ~~upper~~ shoulder-belt deflector **5b**, provided with a belt-guiding member, which is an aperture **5.9**, by which the shoulder belt portion **1.2** is loosely guided. Finally, the shoulder-belt deflector **5b** at the appropriate height is locked by that locking member. When the shoulder-belt deflector **5, 5b** is exploited as a single head-rest tube, fastened to the head rest **3.6a** it must have a feature of nonrotating in an opening of the seat-backrest frame about a longitudinal axis of the opening. Conventional head rest has two stiff head-rest tubes **5.10** (**Fig.** 2), moveable in the seat-backrest frame, guided thereby and locked therein. Alternatively, the shoulder-belt deflector **5a** (**Fig.** 2), serving as a belt-guiding member, can be attached either to the head rest **3.6a** or to the head-rest tube **5.10** or to the upper portion of the shoulder-belt deflector **5a**.

When a head rest of fixed height (**Fig.** 3) is integrated in the seat of, for example, a Volvo, a Ferrari or a Porsche, a space-saving, height-adjustable shoulder-belt deflector **5b** can always be installed in either side (free region) **3.22** of the seat backrest **3.2**.

When the height-adjustable head rest is adjusted to the height of a head of any passenger, the shoulder-belt deflector with the shoulder belt portion adapts itself to his body proportion.

As the alternative feature for easy access of the released main latch plate **9**, it, loosely retained by a main-latch-plate adaptor (not drawn) fastened to the lap belt portion, is positioned in resting position at the height of, for example, the elbow of the sitting passenger when the belt retractor **13** retracts the shoulder belt portion through the shoulder-belt deflector. The main-latch-plate adaptor can be a snap-in clip, which, made of a plastic material, consists of two pieces, a stud of one of which is inserted through the lap belt portion and into an opening of the other and snap-in engaged therewith, as known in the art.

~~The belt-feeding devices **20a, 20b** have to meet the following criteria:~~

— Passengers freely get in and out of the vehicle compartment thanks to the distances of „a" and „b" between the post section **91** and operating arm **20.2a** (**Fig.** 16) in resting position; and

— the device, when moved, doesn't interfere with the head rest **3.6a**, height-adjustable about „Δh_K", and with the head of the passenger with/without hat **92**.

Regarding the kinematics of the height-adjustable belt housing **20.4a** with the latch plate **2** from the operating position to the resting position, the trajectories of „Ba2" and „Bb" are not in the range of a hat thanks to a radial-adjustable tube **20.3** incorporated into the operating arm **20.2a**. Without the radial-adjustable tube **20.3** the operating arm in the trajectory of „Ba1" interferes with that hat.

In the 4th and 5th embodiment ref. to **Figs.** 18, 19 the belt feeding devices **20c, 20d** differ from each other by the rotatory movement of the operating arm **20.2**, whose guide tube **20.1** is pivotally attached to a bearing casing **20.10**. Preferably, upon the rotation about the head, the translatory and rotatory movement of belt are synchronised.

To form the upper part of the seat backrest frame **3.4d** a pair of angle fittings **26a**, a pair of rollover tubes **20.2b** and a pair of side girders **27.1a** or four tubes **27.1** (not drawn) are form- and/or force-locking connected to each other by connecting pins **26.2**, **26.3** (drawn with dotted lines) and/or by welding, bolting, glueing and/or riveting. The belt housing **20.4c** or **20.4d**, having a moveable safety bracket **20.6**, is guided by rollover tubes **20.2b** and driven by an electrical motor **20.5** along the threaded spindle **20.1a**, fastened to both angle fittings **26a**, from the resting position (drawn with dotted lines) to the operating position, and back again. In the operating position the holes of the rollover tube **20.2b** and belt housing **20.4d** are aligned with each other, thus permitting the legs of the safety bracket **20.6**, loaded in the event of rollover of a convertible, roadster or sport-utility vehicle, to project therethrough and clamp or jam the first shoulder belt portion **1.1**.

Upon plug-in connection of the latch plate **2** with the buckle assembly **4, 4a, 4b** the belt end ER of belt portion **1.1** is connected to the coupling fitting **1.2a, 1.2b** (**Figs.** 12a, 12b), whereto a number of energy absorbers is attached to absorb energy. In a cost-saving embodiment without the latch plate **2** and buckle assembly, the belt end ER of belt portion **1.1** is directly connected to the coupling fitting **1.2a** or **1.2b** (**Fig.** 18) to receive energy absorbers, the retaining elements of which are fastened to the seat backrest frame **3.4d**. In order to absorb great energy and damp strong vibration in the event turbulence-related vibrations of an

aeroplane or accident of a fast speeding car or high-speed train, the belt retractor **13**, coupling fitting **1.2b** of which is connected to energy absorbers, is moveable attached to the oblong holes of a stiff plate **13.3**, fastened to the seat backrest frame in the side SR so that the other belt end EL can be exploited to receive additional energy absorbers. In excess of threshold value the belt retractor pulls the clamping elements along the respective retaining elements to absorb energy and damp vibration.

In the 1st and 2nd embodiment (**Figs.** 12, 21) the buckle assembly **4a, 4b, 4c** is form- and/or force-locking connected to the seat backrest frame.

For the convenience of the passenger when egressing from the vehicle and in cases of emergency the following embodiments of detachment are proposed:

To disconnect the latch plates **2, 11** and/or **25** from the buckle assemblies **14, 14a, 15, 15a** (**Fig.** 1) and buckle assemblies **18, 18a, 18b, 18.1 to 18.3, 19, 19a, 19b, 19.1 to 19.3** (**Fig.** 23) of the seat arrangement, particularly for children, as well as from the buckle assemblies **7, 8, 8a to 8d** (**Figs.** 1, 14), the master release button **84**, when depressed, activates the release cables **4.2** and/or electrical release motors **4.2b**, which pull the release button **84a** and/or **84b** of the buckle assemblies (**Figs.** 12a, 12b, 21).

When depressing the master release button **84** the drive apparatus of the belt-feeding device **20, 20a to 20d** returns the first shoulder belt portion **1.1** from the operating position to the resting position.

According to the traffic- or flight law during the travel or turbulence-related flight passengers must remain belted. The need for a belted mother becomes apparent, when she must take care of her frightened children seating on the rear seat. The separately operated release button **84c, 84d**, when depressed, detaches only the latch plates **11, 25** of the lap belt portion from the assemblies **7, 8, 8a, 8d** (**Figs.** 1, 23) to annul the protection from submarining.

In the 1st embodiment (**Figs.** 19 to 21) the height- and width-adjusting mechanism **27** comprises a frame **29**, buckle assembly **18.3, 19.3**, a pair of tubes **27.4**, members **27.5 to 27.9** and a pair of tubes **27.1** having a plurality of locking slots, in form- and force-locking connection with an angle fitting **26a**. The frame **29** consists of a pair of outer tubes **27.3**, a pair of tubes **27.2** and a connecting member of all tubes. The locking handle **27.5** is form- and force-locking connected to the slots of the inner tubes **27.4**.

These inner tubes **27.4**, inserted into the outer tubes **27.3**, are pre-loaded by the springs **27.6**. Each spring **27.6** on a sleeve **27.7**, secured by pin **27.8**, protruding through the holes of the inner tube **27.4**, presses against the spring rest **27.9** of the outer tube **27.3**.

The locking handle **27.5** is in engagement with a pair of locking slots of tubes **27.1**. The locking handle **27.5**, when pulled out from both slots, is detached therefrom. The height of mechanism **27** and buckle assembly can be adjusted

The outer tube **27.3** is provided with a plurality of locking slots q, r, s etc., drawn with dotted lines in **Figs.** 20, 22.

After the pawl **18.10**, pre-loaded by the spring **18.5**, is detached from the locking slot r by its movement in the direction of arrow (**Fig.** 21), the housing **18.12**, form-locking connected to the buckle assembly **4c**, can be moved along both outer tubes **27.3**.

Belt-detachable U-shaped latch plates **25** offer the passengers a feature to adapt their body proportions to the appropriate attachment points into which the latch plates **25** are inserted (**Figs.** 19, 23). Any belt portion, such as **1.1, 1.2**, is loosely guided thereby, secured by a quick-release pin **25.1** thereof and detached therefrom by pulling the quick-release pin.

For juxtaposed seats in vehicles, buses, trains and aeroplanes it is recommended to use a single locking handle **27.5** to operate the 2nd embodiment of the height- and width-adjusting mechanism **27a** of each seat **3c** having, for example, three pairs of openings **18.1 /19.1 to 18.3 / 19.3** to receive a pair of latch plates (**Figs.** 22, 23).

The frame **29a** consists of two pairs of outer tubes **27.3**, two pairs of tubes **27.2**, a pair of connecting members of all tubes and members **18.3, 19.3, 27.6 to 27.9a, 27.11**, attached to the outer tubes **27.3**.

The locking handle **27.5** is form- and force-locking connected to slots of the inner tubes **27.4** by the pins **27.12**. After inserting these inner tubes into the outer tubes **27.3** the locking plate **27.10** is form- and force-locking connected to the slots of the inner tubes and to the pins **27.12**.

After securing the spring rest **27.9a** by the retaining rings **27.11**, both sleeves **27.7a** by the pins **27.8**, protruding through the holes of inner tubes **27.4** and oblong holes of outer tubes **27.3**, the inner tubes with locking handle **27.5** are pre-loaded by springs **27.6**. The locking handle **27.5**, when pulled out from both slots, is detached therefrom. The height of height- and width-adjusting mechanism **27a** can be adjusted.

Although the present invention has been described and illustrated in detail, it is clearly understood that the terminology used is intended to describe rather than limit. Many more objects, embodiments, features and variations of the present invention are possible in light of the above-mentioned teachings. Therefore, within the spirit and scope of the appended claims, the present invention may be practised otherwise than as specifically described and illustrated.

What is claimed:

Claims (cancelled) **1** to **10**, **12** to **27**, **31** to **43**

Claim ~~30~~**1**. (currently amended) A shoulder-belt-portion guiding assembly for more convenience and increased survival chance of a passenger of a transport system in an accident or during an in-flight turbulence, comprising ~~The multi-point seat belt according to claim 4, wherein~~ a ~~upper~~ height-adjustable shoulder-belt deflector **(5, 5a, 5b)**, ~~having an aperture to loosely guide the second shoulder belt portion, is attached to a height-adjustable head rest **(3.6a)** where an adaptation of a height thereof to a head of the passenger results in a self-adaptation of both shoulder belt portions, extending crosswise over the upper part of his body in the X-shape, to his body proportion.~~ which, serving as a member of a head rest **(3.6, 3.6a)** of a seat of the transport system, when adjusted to a body proportion of the passenger, loosely guides a shoulder belt portion of a seat belt, which downwardly extends over a shoulder and an upper ~~body part of a~~ body of the belted passenger; and prevents neck-injury in the accident or during the in-flight turbulence.

Claim ~~9~~**2**. (currently amended) The shoulder-belt-portion guiding assembly ~~multi-point seat belt~~ according to claim ~~3~~**1**, wherein ~~a lower portion of the non-height-adjustable upper belt deflector~~ the head rest **(3.6a)** is height-adjustable and has the shoulder-belt deflector **(5a)** and ~~at least~~ one stiff head-rest tube **(5.10)**, which, moveable in an opening of a seat-backrest frame, guided thereby and locked therein, is nonrotating about a longitudinal axis of the opening, where the head rest is adjusted to a height of a head of the passenger, thus resulting in a self-adaptation of the shoulder-belt deflector with the shoulder belt portion to the body proportion of the passenger~~in the seat backrest is provided with a coupling fitting **(1.2a, 1.2b)** to receive energy absorbers~~.

Claim ~~9~~**3**. (currently amended) The shoulder-belt-portion guiding assembly ~~multi-point seat belt~~ according to claim ~~3~~**1**, wherein ~~a lower portion of the non-height-adjustable upper belt deflector~~ the head rest **(3.6a)** is height-adjustable and has the shoulder-belt deflector **(5a)** and at least two stiff head-rest tubes **(5.10)**, moveable in a seat-backrest frame, guided thereby and locked therein, where the head rest is adjusted to a height of a head of the passenger, thus resulting in a self-adaptation of the shoulder-belt deflector with the shoulder belt portion to

the body proportion of the passenger~~in the seat backrest is provided with a coupling fitting (1.2a, 1.2b) to receive energy absorbers~~.

Claim ~~11~~4. (currently amended) The shoulder-belt-portion guiding assembly ~~multi-point seat belt~~ according to claim ~~8~~3, wherein upon non-use of the seat belt a main latch plate, movable along the shoulder belt portion or a lap belt portion up to a main-latch-plate adaptor, fastened to the lap belt portion, is released from a main buckle assembly, where the passenger, wanting to use the seat belt, easily accesses the released main ~~shoulder~~ latch plate, positioned between the shoulder-belt deflector and the main-latch-plate adaptor~~when being plug-in connected to an assisting buckle assembly (16, 16a, 16b) which, having an easily-accessible release button, is arranged to the seat~~.

Claim ~~11~~5. (currently amended) The shoulder-belt-portion guiding assembly ~~multi-point seat belt~~ according to claim ~~8~~3, wherein upon non-use of the seat belt a main latch plate, movable along the shoulder belt portion or a lap belt portion up to a main-latch-plate adaptor, fastened to the lap belt portion, is released from a main buckle assembly, where the passenger, wanting to use the seat belt, easily accesses the released main ~~shoulder~~ latch plate, which, loosely retained by the main-latch-plate adaptor, is positioned at a height of an elbow.~~when being plug-in connected to an assisting buckle assembly (16, 16a, 16b) which, having an easily-accessible release button, is arranged to the seat~~

Claim 6. (new) The shoulder-belt-portion guiding assembly according to claim 4, wherein the adaptor is a snap-in clip, consisting of two pieces, a stud of one of which is inserted through the belt portion and into an opening of the other and snap-in engaged therewith.

Claim 7. (new) The shoulder-belt-portion guiding assembly according to claim 5, wherein the adaptor is a snap-in clip, consisting of two pieces, a stud of one of which is inserted through the belt portion and into an opening of the other and snap-in engaged therewith.

Claim ~~28~~8. (currently amended) The shoulder-belt-portion guiding assembly ~~multi-point seat belt~~ according to claim ~~3~~1, wherein the ~~upper~~ shoulder-belt deflector (5, 5b), guided by a seat-backrest frame and movable therein, has

an upper portion, which, projected through a top edge of the seat backrest, is provided with a belt-guiding member, by which the shoulder belt portion is loosely guided; ~~height-adjustable~~ and ~~provided with~~

a locking handle **(5.2)**, having a locking member, which, when unlocked, allows the belt-guiding member with the shoulder belt portion to be ~~by movement of which a height thereof is~~ adapted to ~~a~~ the body proportion of the passenger.

Claim **9.** (new) The shoulder-belt-portion guiding assembly according to claim **8**, wherein the belt-guiding member is an aperture **(5.9)**.

Claim **10.** (new) The shoulder-belt-portion guiding assembly according to claim **8**, wherein the belt-guiding member is a shoulder-belt deflector **(5a)**.

Claim **11.** (new) The shoulder-belt-portion guiding assembly according to claim **8**, wherein the height-adjustable shoulder-belt deflector **(5b)**, movable in an opening of the seat-backrest frame, guided thereby and locked therein, is nonrotating about a longitudinal axis of the opening.

Claim **12.** (new) The shoulder-belt-portion guiding assembly according to claim **11**, wherein the shoulder-belt deflector, exploited as a single head-rest tube, is made of a material with a high tensile strength and an end portion of the upper portion is attached to the head rest.

Claim **13.** (new) The shoulder-belt-portion guiding assembly according to claim **12**, wherein the belt-guiding member is an aperture **(5.9)**.

Claim **14.** (new) The shoulder-belt-portion guiding assembly according to claim **12**, wherein the belt-guiding member is a shoulder-belt deflector **(5a)**.

Claim ~~11~~**15.** (currently amended) The shoulder-belt-portion guiding assembly ~~multi-point seat belt~~ according to claim **8**, wherein upon non-use of the seat belt a main latch plate, movable along the shoulder belt portion or a lap belt portion up to a main-latch-plate adaptor, fastened to the lap belt portion, is released from a main buckle assembly, where the passenger, wanting to use the seat belt, easily accesses the released main ~~shoulder~~ latch plate, positioned between the shoulder-belt deflector and the main-latch-plate adaptor~~when being plug-in connected to an assisting buckle assembly **(16, 16a, 16b)** which, having an easily-accessible release button, is arranged to the seat~~.

Claim ~~11~~**16.** (currently amended) The shoulder-belt-portion guiding assembly ~~multi-point seat belt~~ according to claim **8**, wherein upon non-use of the seat belt a main latch plate, movable along the shoulder belt portion or a lap belt portion up to a main-latch-plate adaptor,

fastened to the lap belt portion, is released from a main buckle assembly, where the passenger, wanting to use the seat belt, easily accesses the released main ~~shoulder~~ latch plate, which, loosely retained by the main-latch-plate adaptor, is positioned at a height of an elbow ~~when being plug-in connected to an assisting buckle assembly **(16, 16a, 16b)** which, having an easily-accessible release button, is arranged to the seat~~

Claim **17.** (new) The shoulder-belt-portion guiding assembly according to claim **15**, wherein the adaptor is a snap-in clip, consisting of two pieces, a stud of one of which is inserted through the belt portion and into an opening of the other and snap-in engaged therewith.

Claim **18.** (new) The shoulder-belt-portion guiding assembly according to claim **16**, wherein the adaptor is a snap-in clip, consisting of two pieces, a stud of one of which is inserted through the belt portion and into an opening of the other and snap-in engaged therewith.